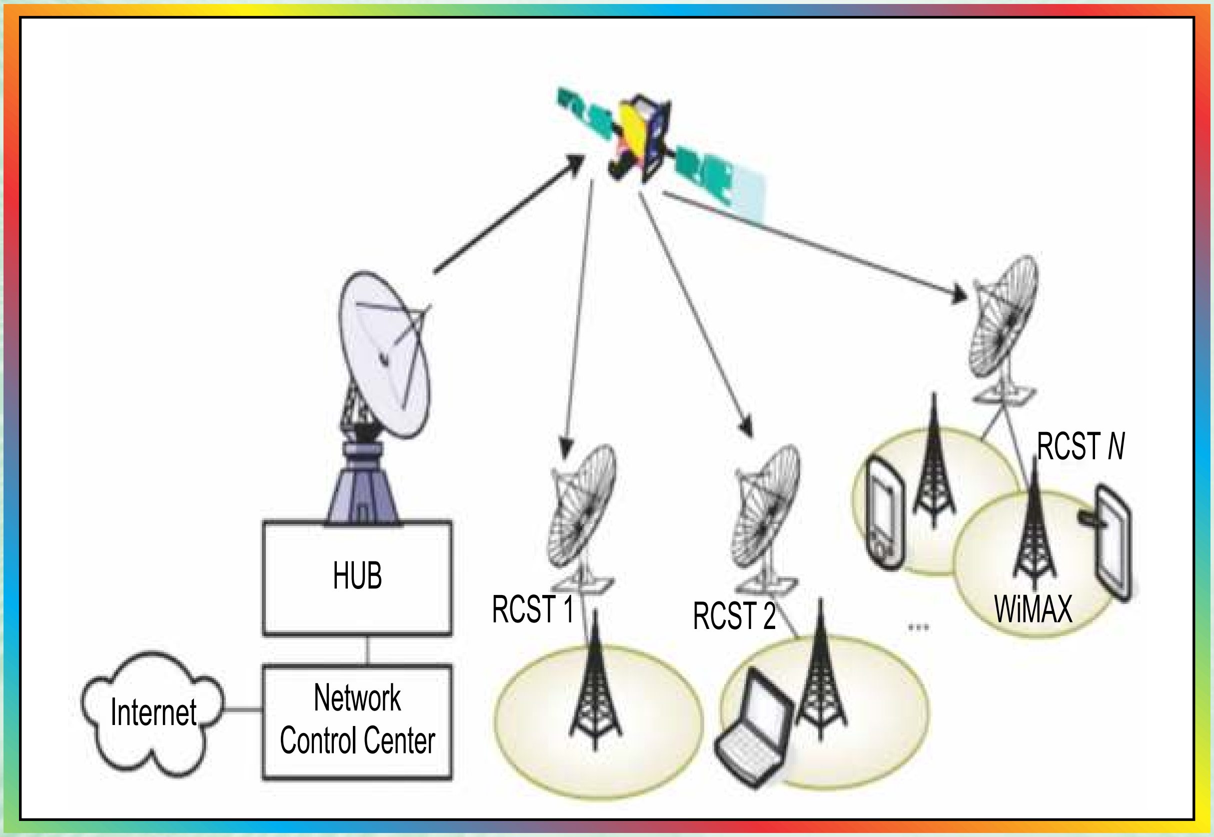
ISO 9001 : 2008

# TEC टी ई सी संचारिका NEWSLETTER

VOL. 18 JANUARY 2014 ISSUE 1

## HYBRID SATELLITE-TERRESTRIAL SYSTEM




ISO 9001:2008
TELECOMMUNICATION ENGINEERING CENTRE

**IN THIS ISSUE**

## 1.0 Introduction:

Telecommunication networks of the future are believed to involve systems that will work on different technologies, such as WiFi, WiMAX, 2G/3G, LTE, and satellite. In order to efficiently orchestrate the working of the different technologies, the idea of hybrid networks is being seriously considered. The chief driving factor is to facilitate and then exploit the cooperation of different wireless communication systems (segments) to provide varied range of services to users in the most efficient and seamless way, taking into account signal quality (coverage), traffic congestion conditions, and cost issues. Hybrid networks have the ability to be an efficient and cost-effective solution to employ satellite communications for not only broadcast and multicast services but also for mobile services.

The intrinsic capabilities of satellite networks, for instance very large coverage areas, speed of implementation and inherent multicasting and broadcasting capabilities make them the prime choice to serve niche areas like coverage in planes, navy ships, hostile environments etc. Therefore, the idea of jointly benefiting from the advantages and capabilities of both terrestrial and satellite telecommunication systems is gaining much impetus. In particular, the satellite network can provide the best and most comprehensive coverage for low-density populations, while the terrestrial network or the ground component can provide the highest bandwidth and lowest cost coverage for high-density populations in urban environments.

## 2.0 Definition of Hybrid Satellite-Terrestrial System

As per ITU-R recommendations,

*"A hybrid satellite/terrestrial system is a system employing satellite and terrestrial components where the satellite and terrestrial components are interconnected, but operate independently of each other. In such systems the satellite and terrestrial components have separate network management systems and do not necessarily operate in the same frequency bands."*

## 3.0 Main Drivers for Hybrid Satellite-Terrestrial Systems

The main driving forces behind the Hybrid system are as follows:-

- Service coverage extension.
- Broader range of service provisioning and/or lower costs for customers and operators.
- Rapid and/or infrastructure independent service deployment.
- Increase in the Quality of Service (QoS) delivered to the operators and end-users alike.
- Optimizing the usage of the resources of the telecommunications networks by selecting the most appropriate network for the transmission of each service.
- Increased service availability and/or resilience.
- Optimization of the operational/overall investment cost when deploying a new service.
- Optimization of the energy required for conveying information to recipients by taking advantage of the broadcast/ multicast capability of the solar powered satellite infrastructure.

## 4.0 Network Scenarios for Hybrid Satellite-Terrestrial Systems

Various network scenarios that can be envisaged to employ the hybrid architecture are discussed below. These scenarios are based on ETSI standard TR 103124.

### *4.1 Broadcast services*

In this scenario, requirement is to combine a satellite and a terrestrial component to broadcast media content including radio and TV programs, to vehicular or even handheld devices. Broadcast services generally require the provisioning of a unidirectional satellite link between the network component and the satellite segment, mainly because the high bandwidth consumption in such an implementation is on the downlink (i.e. from network to user equipment). The preferred spectrum is a frequency band allocated to Mobile Satellite Services (MSS) in L (1.5 GHz and 1.6 GHz) or S band (1.9 GHz and 2 GHz). Each end user terminal should be able to receive both satellite and terrestrial signals for smooth service continuity over the coverage and to allow combining terrestrial and satellite signals when both have acceptable quality in order to achieve diversity gains.

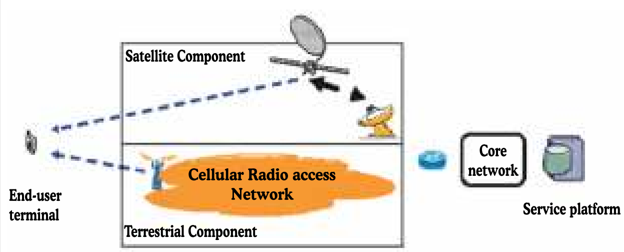



Figure 1: Unidirectional Satellite link implemented in a terrestrial network for mobile user equipment

Similar implementation could be there for fixed terminals where a user connected to an ADSL broadband network can be provided high bandwidth consuming services like IPTV or Video on Demand through the satellite segment of the network while other low bandwidth demanding services could be served by the terrestrial (in this case ADSL) network in place. The preferred spectrum is frequency bands allocated to Fixed or Broadcast Satellite Services (FSS or BSS) in Ku or Ka band.

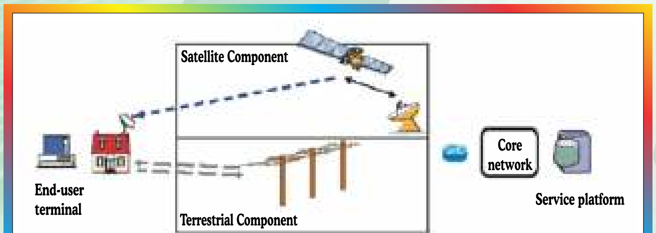



Figure 2: Unidirectional Satellite link implemented in a terrestrial network for fixed terminal

## 4.2 Telecom access network services

For the purposes of geographic extension of the services and to facilitate traffic sharing in 2 or 2.5 G (GSM, GPRS) and 3G networks (UMTS), satellite systems can advantageously be used as additional Satellite Radio Access Network (S-RAN). The S-RAN is a collaborative extension of the classical terrestrial cellular 2G/3G RAN. When a S-RAN is available, the most obvious gain comes from the possibility to greatly extend the coverage of classical cellular terrestrial wireless RANs which are not covering remote areas. The satellite network operates in both forward and return directions to provide an alternative access network for mobile user equipment. The same equipment can also latch to a terrestrial cellular network to access the same or other services. The spectrum for the satellite component in such hybrid architecture is a frequency band allocated to Mobile Satellite Services (MSS) in L (1.5 GHz and 1.6 GHz) or S band (1.9 GHz and 2 GHz). These frequency bands are preferred so that the same user equipment can work without any interruption of services in the satellite as well as the terrestrial segment of the hybrid architecture.

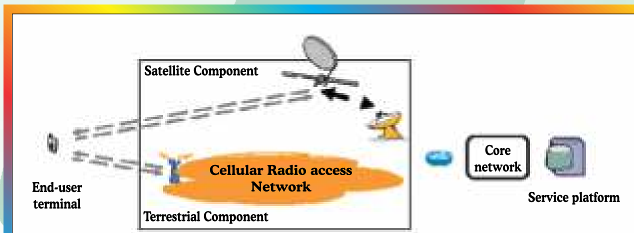



Figure 3: Bidirectional Satellite link implemented in a terrestrial network for mobile user equipment

Similar implementation can be done for the fixed terminal equipments where a bidirectional satellite link can be employed in a collaborative manner with the existing terrestrial network, say in this case, an ADSL broadband network. The preferred spectrum is frequency bands allocated to Fixed or Broadcast Satellite Services (FSS or BSS) in Ku or Ka band. Again in this case as well, the pre-deployed infrastructure can be leveraged to add to cost-effectiveness of the system.

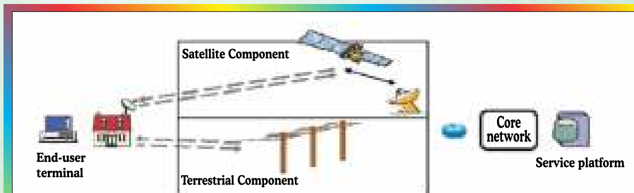



Figure 4: Bidirectional Satellite link implemented in a terrestrial network for fixed terminal

Adding a satellite bidirectional link enables greater flexibility in routing the traffic between both components while at the same time, it ensures a higher resiliency towards potential interruption of service on the terrestrial access link (Typically up to several days or weeks of disruptions). The satellite link can also be bidirectional as the bandwidth requirement for upload is also increasing as more and more users are uploading video etc.

### 4.3 Backbone technology: Trunking & Backhauling

In remote areas or hostile environments like navy, military operations or reconnaissance missions where terrestrial network penetration is almost negligible, hybrid network could be so envisaged that the satellite segment of the network can be used to connect two or more terrestrial segments of the network which can be either PSTN, PLMN or any other wire-line/wireless networks.

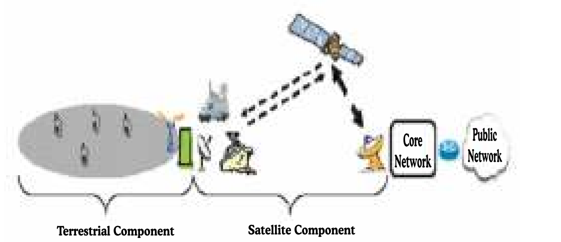



Figure 5: Backhauling of mobile services using satellite segment in a hybrid system

Another widespread use of satellite systems in hybrid networks consists in the interconnection of private, Local Area Networks (LANs) or of Mobile Ad-hoc NETworks (MANETs). The hybrid architecture focuses on broadband inter- MANET connectivity, using in each MANET a specific central node for communication with other MANETs.

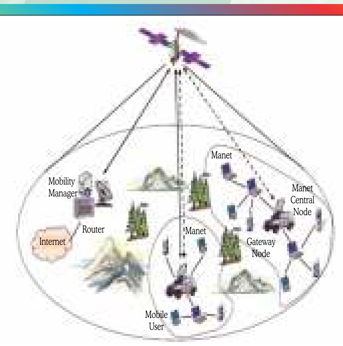



Figure 6: Hybrid satellite-terrestrial architecture with MANETs

In rural areas, the hybrid architecture can be implemented such that the satellite segment can be utilized to connect the access network nodes like a group of BTS or Node-Bs, in case of PLMNs, scattered in the remote rural areas to the core network node i.e. the BSC in this case. Another scenario could be the traffic aggregated at BSC connected to the MSC using the satellite segment. The network structure is based on ITU-R recommendation M.1850.

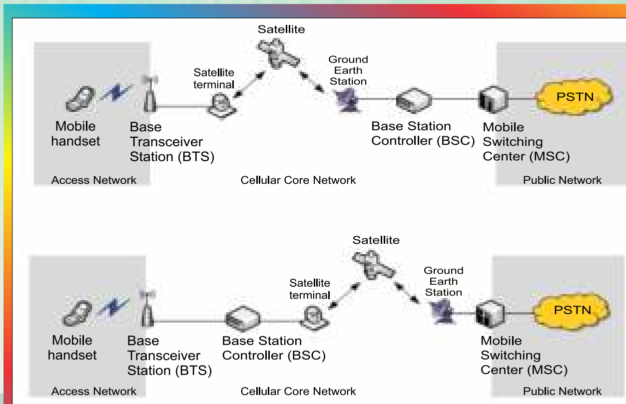



Figure 7: Hybrid architecture where satellite segment is used to connect group of BTS to BSC or aggregated traffic from BSC to MSC in case of PLMN

### 4.4 For content delivery services

A content delivery network (CDN) aims at distributing/replicating multimedia content towards data centers in the transport network so that the content is served to end-users with higher service availability and performance. CDNs serve a large fraction of the Internet content today, including web objects (text, graphics, URLs and scripts), downloadable objects (media files, software, documents), applications (e-commerce, portals), live streaming media, on demand streaming media, and social networks. With the increase in the number of data centers, the inherent cost effective multicast/broadcast capability of satellite becomes more relevant for CDNs. The benefits of using satellites include the transport of high volumes of bulk data, between any CDN nodes located within the satellite coverage in a single satellite hop and also offloading terrestrial networks so that they can handle more easily short haul connections requiring small delays (time-sensitive services). The terrestrial component of the hybrid architecture deployed for CDNs is typically made of wireline/wireless transport/access networks with data centers to distribute the content directly to fixed and mobile end users.

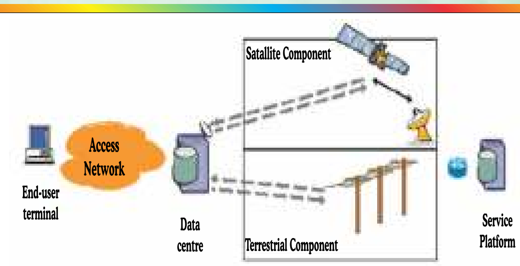



Figure 8: Satellite based Content Delivery Network

## 5.0 Network functionalities of Hybrid Satellite-Terrestrial Systems

Discussed below are some of the parameters of the hybrid architecture which govern the proper and efficient functioning of this system.

### *5.1 Handovers between the terrestrial and satellite segments*

In hybrid systems, handover of services from terrestrial segment to satellite segment of the network is tricky and becomes much more complicated. In hybrid satellite architectures, inter-system handover shall be performed. Also, handover initiation might depend upon load balancing or even more complicated factors like different cost functions, network state and specific connection admission control procedures with forced handover. Since, in the case of hybrid architecture, the handover has to take place between different radio access technologies, this fits the case of vertical handovers or MIH (Media Independent Handovers), specified in IEEE 802.21 (2008) which enables handover of sessions from one layer 2 access technology to another. However, as per ITU M.1850 specification, the implementation of handovers in hybrid networks is still left to the operator as per his requirements.

### *5.2 Protocol convergence between terrestrial and satellite segments*

Since there is a difference between the protocols especially at Data Link and Physical Layer of the satellite and terrestrial segment in the hybrid architecture, protocol convergence is of utmost necessity for proper interworking of the two segments. ITU report S.2222 is in place to facilitate protocol convergence for the efficient deployment of hybrid systems. The report identifies the Satellite Dependent and Satellite Independent layers and enables interworking between them via an interface called Satellite Independent -Service Access Point (SI-SAP).

### *5.3 Load balancing*

In hybrid systems, mainly three different possibilities for load balancing have been foreseen: per packet, which guarantees equal load per link but which suffers from the need for packet reordering at the reception side, per destination, which suffers from unequal traffic distribution among the different available links and from the handling of a lot of independent destinations, and finally, per flow which uses higher layer information (e.g. TCP layer in addition to the IP address) to determine the network that shall be used to carry each independent traffic flow.

### *5.4 Quality of Service (QoS)*

ETSI has released a standard based on DiffServ mode to facilitate the QoS requirements in hybrid networks. This standard distinguishes Satellite Dependent (SD) from Satellite-Independent (SI) layers, linked together via a standardized, SD layers agnostic interface called the Satellite Independent Service Access Point (SI-SAP). The standard relies upon the management of abstract queues called Queue IDentifiers (QID). Each QID is associated with a given class of quality of service. IP datagrams saved in these queues shall be processed according to their QoS class by the SD layers, responsible for the assignment of the satellite capacity and of a particular forwarding behavior.

## 6.0 Satellite-UMTS or S-UMTS – Future Implementation scenario of Hybrid Satellite-Terrestrial System

S-UMTS stands for the Satellite component of the Universal Mobile Telecommunication System. S-UMTS systems will complement the terrestrial UMTS (T-UMTS) and inter-work with other IMT-2000 family members through the UMTS core network. Some of the benefits to be gained from a fully integrated S-UMTS/T-UMTS system are: seamless service provision; re-use of the terrestrial infrastructure; highly integrated multi-mode user terminals. The satellite component of UMTS may provide services in areas covered by cellular systems, complementary services, e.g. broadcasting, multicasting, and in those areas not planned to be served by terrestrial systems.

Studies have identified two major roles of S-UMTS with regard to its terrestrial analogue. The first - characterized as geographical complement implies that S-UMTS offers the same set of services that are provided by T-UMTS to its users. The second –called service complement or close cooperative- suggests that S-UMTS should not attempt to offer voice or interactive services, where it has a disadvantage compared to the terrestrial networks. It should rather focus on the provision of multicast and broadcast services since it has the potential to provide these services in the most cost-efficient manner.

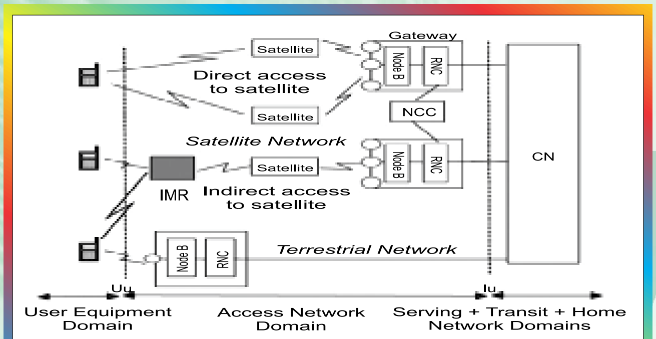


Figure-9 S-UMTS Reference Architecture

An Intermediate Module Repeater (IMR) is employed in the S-UMTS network which adapts the satellite signals to the MT interfaces and enables full independence from the terminal segment and secondly it improves the satellite coverage in the shadow areas as well as in urban areas where satellite signals inside buildings is highly faded.

## 7.0 Network examples of Hybrid Satellite-Terrestrial Systems

Discussed below are some of the examples of the networks that have been deployed or planned to be deployed using the hybrid architecture.

### 7.1 For mobile user telecom access services

- Thuraya Satellite System: This system provides integration of satellite and terrestrial segments at terminal level only. Satellite Radio Interfaces used are GMR-1, GMPRS-1 and the terrestrial radio interfaces are GSM, GPRS.
- SkyTerra/ LightSquared System: This system provides integration of satellite and terrestrial segments at terminal level, service, system/network levels and spectrum (L Band). Satellite Radio Interfaces used are GMR-1 3G and the terrestrial radio interfaces are UMTS, LTE.
- Terrestar System: This system provides integration of satellite and terrestrial segments at terminal level, service, system/network levels and spectrum (S Band). Satellite Radio Interfaces used are GMR-1 3G and the terrestrial radio interfaces are UMTS, LTE.

### 7.2 For Broadcast/Multicast services

- In Europe, Deutsche Telekom (t-entertainment service) and SFR are currently offering a triple play service including HD TV using an ADSL access and satellite reception. The satellite downlink is used to deliver TV channels to complement the basic Internet service provided by the ADSL connection.

### 7.3 For backhauling & trunking in core network

- The most popular application of hybrid architecture is being put into use in backhauling of GSM cells at the Abis interface (Interface between the Base Station Controller and the Base Stations Transceivers).
- "France Telecom", the French operator, has deployed a solution based on hybrid architecture which consists in connecting two sections of the PSTN with a satellite link. As soon as several remote users desire to communicate together, their data are gathered and carried over satellite, and experience therefore a high delay characteristic of the transmission over geostationary satellites.

## 8.0 Conclusion

As we are advancing towards an information-driven society, the development of a converged communication and service infrastructure is extremely crucial. The chief motivation is to utilize the hybrid architecture for a converged service capability across heterogeneous accesses for ubiquitous broadband services, integrating wired and wireless, fixed and mobile technologies. It is therefore important to achieve service portability and continuity across composite networks with ubiquitous access, involving any network, any technology, any domain, and any administrative domain. The upcoming architecture in the future should be service-oriented; the network should be pervasive, to efficiently support applications like peer-to-peer applications, video on demand, and multicast.

In this article, a number of possible roles of the satellite component in hybrid satellite/terrestrial networks, as well as the parameters for optimization and efficient working of these hybrid networks have been discussed. The driving factor is in identifying the potentialities and showing advantages in adopting hybrid network solutions involving the satellite component in the present networks so that the advantages of satellite communication could be efficiently leveraged and the realm of ubiquitous and seamless communication could be established.

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3. Hybrid satellite/terrestrial networks: State of the art and future perspectives; Nicolas Courville, Hermann Bischl, Erich Lutz, Ales Svigelj, Pauline ML Chan, Evangelos Papapetrou, Rafael Asorey-Cacheda.
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5. C. Haardt, N.Courville, “Internet by Satellite: a flexible Processor with Radio Burst Switching”, Proceedings of the 2nd International Workshop on Satellite and Space Communications, (IWSSC 2006), Madrid, Spain, 14-15 September 2006.
6. Evaluation of cooperative techniques for hybrid/integrated satellite systems , Sooyoung Kim
7. SERVICE SCENARIOS AND SYSTEM ARCHITECTURE FOR SATELLITE UMTS IP BASED NETWORK (SATIN), B.G.Evans, M.Mazzella, G.E.Corazza, A.Polydoros, I.Mertzanis, P.Philippopoulos, W.De Win


## Approvals from OCT 2013 to DEC 2013

| S.No | Company/Product |
|---|---|
| 1. | M/s Sunren Technical Solutions Pvt. Ltd., |
| 1.1 | G - 3 FAX Machine |
| 1.2 | G - 3 FAX Machine, Dell B1165nfw |
| 1.3 | G - 3 FAX Machine, Dell B2375dnf |
| 1.4 | V.90 MODEM ,Model:Delphi D40-AM5 |
| 2. | M/s One Network (India) Pvt. Ltd. |
| 2.1 | V.90 MODEM |
| 3. | M/s TEJAS NETWORKS LTD |
| 3.1 | Carrier Ethernet for Access Network,TJ 2030 |
| 3.2 | STM-1 Synchronous Multiplexer (TM/ADM),TJ1400 (STM-1) |
| 3.3 | STM-4 Synchronous Multiplexer (TM/ADM),TJ1400 (STM-4) |
| 4. | M/s Alphion India Pvt Ltd |
| 4.1 | Optical Splitter for PON,ASPL |
| 5 | M/s Huawei Technologies Co. Ltd |
| 5.1 | Switching Node with Network-Network Interface with STM-1,MSOFTX 3000 with UMG 8900 |
| 6. | M/s Aspect Contact Centresoftware (I) Pvt LTD |
| 6.1 | System Employing Computer Telephony Integration,Aspect Call Centre Enterprise |
| 7. | M/s Hewlett Packard India (Sales) Pvt.Ltd., |
| 7.1 | G - 3 FAX Machine, SNPRC-1401-02 |
| 7.2 | G - 3 FAX Machine, SNPRH-1201 |

**हिंदी कार्यशाला :** दूरसंचार इंजीनियरी केंद्र द्वारा दिनांक 31 दिसंबर 2013 को एक हिन्दी कार्यशाला काआयोजन किया गया। श्री एच के मक्कड़ निदेशक (तकनीकी), राजभाषा विभाग द्वारा इस कार्यशाला में राजभाषा नीति और जांच बिन्दु के बारे में व्याख्यान दिया गया तथा शब्द कोष, नियम और हिन्दी अनुवाद के लिए उपयोग में लाये जा सकने वाले सॉफ्टवेयर के बारे में प्रकाश डाला गया।

**श्री एच. के. मक्कड़, निदेशक (तकनीकी), राजभाषा विभाग तथा कार्यशाला में भाग लेते हुये अधिकारी एवं कर्मचारीगण**

# Important Activities of TEC during OCT 13 to DEC 13

**GRs/IRs Issued :**

- IR on CDMA Data Card, 3G Data card
- IR on Network-Network Interface for SBC
- GR on L-Band Intermediate Data Rate Modem for C and Ku Band
- GR on UPS, VRLA Batteries
- GR on 23GHz High Performance Antenna

**DCC conducted on :**

- GR on Server ,MPLS Router based Transport Network
- IR on Router, Universal Battery Charger
- IR on Radio Modems
- GR on Cordless Telephone
- GR on SBC and LMG

**Other activies :**

- NWG meeting for ITU-T Study Groups 9,12 and 17 held in TEC
- Contribution for NWG 12 & 17 submitted
- Meeting of committee on validation of EMF WEB Portal, Green Telecom and for deliberation on TRAI recommendation on application Services

**White Paper issued on :**

- GPON in mobile backhaul
- Hybrid Satellite-Terrestrial System

**Approvals issued by TEC during the period from OCT 2013 to DEC 2013**

Interface Approvals.....................9
Type Approvals ...........................4
Certificate of Approvals..............0

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## Certifications issued by TEC

**Type Approval (TA)**
**Interface Approval (IA)**
**Certificate of Approval (CoA)**

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**Activities at NTIPRIT**

(a) JTO training covering DOT Functions, IT Tools for Office and experience sharing modules.

(b) Faculty Development Programme on following topics
* IPv6
* Awareness on RTI Act
* Next Generation Network
* Optical Transport Network
* Mobile communication.

(c) Report of Committee for setting up knowledge Repository in NTIPRIT submitted to DOT

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